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(71) Applicant (*for all designated States except US*): OBDUCAT AKTIEBOLAG [SE/SE]; Box 580, S-201 25 Malmö (SE).

(72) Inventors; and
(75) Inventors/Applicants (*for US only*): HÅLLBERG, Mats [SE/SE]; Merkuriusvägen 25, S-181 63 Lidingö (SE). OLSSON, Lennart [SE/SE]; Förridargatan 13, S-216 21 Malmö (SE).

(74) Agent: AWAPATENT AB; Box 5117, S-200 71 Mälmo (SE).

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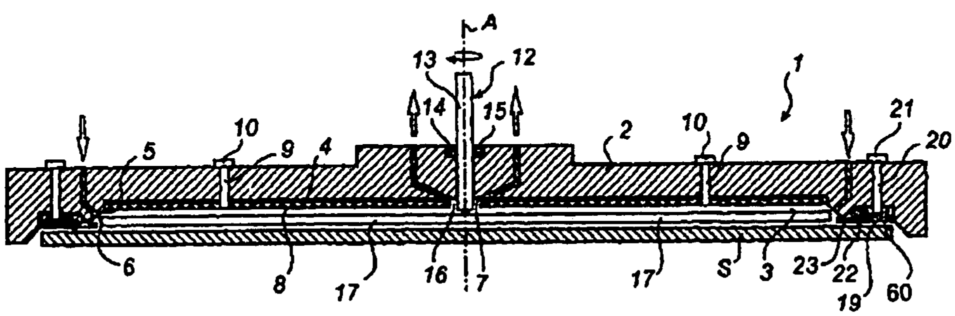
(54) **Title:** APPARATUS AND METHOD FOR ELECTROCHEMICAL PROCESSING OF SUBSTRATES



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(57) **Abstract:** In a method for electrochemical processing of a substrate (S), use is made of an apparatus which comprises a container (1) having a chamber for holding an electrolyte, an electrode member (8) arranged in the chamber, and a substrate holder (60) arranged in the chamber and adapted to carry the substrate (S). A voltage source is connected to the electrode member (8) and the substrate holder (60) to establish, during processing, an electrical field in the electrolyte between the electrode member (8) and the substrate (S) carried by the substrate holder (60). A pressure control means is adapted to establish a subatmospheric pressure in the chamber during the electrochemical processing so that leakage of electrolyte from the container (1) to the surroundings is eliminated and so that the parts of the container (1) are automatically held together by the subatmospheric pressure in the chamber.

APPARATUS AND METHOD FOR ELECTROCHEMICAL PROCESSING OF SUBSTRATES

Field of the Invention

The present invention relates generally to electrochemical processing of a substrate, in particular but not exclusively for structuring the same. More specifically, the invention relates to an apparatus and a method for such electrochemical processing.

Background Art

It is in many cases desirable to produce small structures in a material surface of a substrate. This can be achieved by electrochemical plating of the substrate. Alternatively, the substrate can be subjected to electrochemical etching. In both cases, such electrochemical processing takes place in a cell or container, which defines a chamber containing at least one electrode and an opposite substrate holder. The electrode and the substrate holder are connected to a voltage source, which during the electrochemical processing establishes an electrical field between the electrode and a substrate carried by the substrate holder. An electrolyte is received between the electrode and the substrate. In a plating process, ions pass from the electrolyte and are deposited on the surface of the substrate. In an etching process, parts of the surface of the substrate are dissolved and pass to the electrolyte in the form of ions.

In one type of plating process, the surface of the substrate can be provided with the desired structure, so that an inverted copy is transferred to the metal layer which is deposited on the substrate acting as a cathode. The thus structured metal layer can then be released from the substrate and used as a stamper (matrix), for instance in injection moulding of various products, such as CD, CD ROM, DVD etc. and also vinyl records, holograms etc., or in so-called nanoimprint lithography for manu-

facturing structures in semiconductor materials etc. Alternatively, the structured metal layer can be used as a so-called father by a new metal layer being deposited thereon for making an inverted copy which is used either as a stamper as above or as a so-called mother on which a metal layer is deposited in order to form sons which in turn are used as stampers. This type of plating is disclosed in e.g. US-A-5,843,296 and US-A-5,427,674. In an alternative plating process, an unstructured substrate is arranged as a cathode in the chamber. By suitable masking of the substrate, a desired structure can be formed on the same during plating. According to one more alternative plating process, an even metal layer is deposited on an unstructured substrate. This plating process thus results in an unstructured raw matrix of high surface smoothness which in a separate subsequent step is structured by a suitable method, such as etching. This type of method is disclosed in WO99/63535.

In an etching process, the substrate, which is arranged as an anode in the chamber, can be structured by suitable masking thereof. Alternatively, an electrode surface can be caused to move in a given pattern over the substrate. Different types of electrochemical etching are known from e.g. EP-A-392 738, WO98/10121 and EP-A-563 744. Like in plating, the structured substrate can be used directly as a stamper, for instance in injection moulding or in nanoimprint lithography, or be used for making a mother etc.

A plating cell according to US-A-5,427,674 defines a chamber containing a substrate holder and an electrode in the form of a basket of titanium, which carries balls or rods of the metal that is to be deposited on a substrate. As metal ions are being deposited on the substrate from the electrolyte, new metal ions are emitted from the balls or rods to the electrolyte, so that its metal ion content is essentially constant. The bottom of the basket is plane and provided with a plurality of holes. A sub-

strate holder is arranged opposite the bottom of the basket. During plating, an electrolyte is circulated continuously through the chamber. The electrolyte is pumped vigorously into the space between the electrode and the substrate carried by the substrate holder through holes in the peripheral wall of the chamber, so that turbulence is generated in the electrolyte to eliminate any concentration gradients therein. The electrolyte flows up through the electrode and out of the chamber through a central outlet above the electrode. A pressure above atmospheric is maintained in the chamber during the entire plating process.

The above-mentioned US-A-5,427,674 also discloses an alternative embodiment. In this case the electrode is a so-called dimensionally stable sheet-like anode (DSA) of e.g. platinum-coated titanium. This electrode is essentially inert during the plating process. Therefore a compensating device is provided for the chamber and designed to add in a dosed manner a metal hydroxide to the electrolyte to compensate for the metal ions that are removed from the electrolyte and deposited on the substrate. In this embodiment, a smaller distance between the electrode and the substrate is allowed, which in turn results in higher current density between the electrode and the substrate and lower power consumption. In this case the electrolyte is stated to conveniently flow out of the chamber through an electrolyte outlet in the peripheral wall of the chamber.

In both embodiments above, the cell comprises separable parts, so that the substrate can be introduced into and removed from the chamber. Such a construction causes a high risk of leakage of electrolyte, which is undesirable since the electrolyte often contains substances injurious to health, for instance metals. In view of the risk of leakage, the parts of the cell are therefore in many cases of a strong construction and held together by means of a powerful clamping device, for instance a pis-

ton-and-cylinder unit and an abutment, or a plurality of clamping screws. Another problem of the above apparatus arises when gas forms in the chamber during the plating process, for instance by an inevitable chemical reaction at the electrode. Such gas has been found to interfere with the plating process and cause undesired irregularities in the material deposited on the substrate.

In a plating apparatus according to US-A-5,785,826, the substrate is rotated in the chamber during the plating process in order to eliminate any concentration gradients in the electrolyte. Also this construction will probably have the above problems with leakage and gas which possibly interferes with the plating process. Besides, it is relatively complicated to make the electrically connected substrate rotate in the chamber.

The above problems are also to be found in prior art apparatus for electrochemical etching.

Objects of the Invention

An object of the present invention is to wholly or at least partly overcome the above problems according to prior art, and in particular to provide an apparatus and a method for electrochemical processing with a minimum risk of leakage of electrolyte to the surroundings.

It is also an object to provide an apparatus for electrochemical processing which is of a simple design

Another object is to provide an apparatus and a method for electrochemical processing which result in high surface accuracy of the processed substrate.

It is also an object to minimise the risk of disturbance in the electrochemical process as gas develops in the chamber.

Summary of the Invention

These and other objects that will be evident from the following description are now achieved by an apparatus and a method according to the independent claims. Preferred embodiments are defined in the dependent claims.

The understanding that a subatmospheric pressure is to be established in the chamber during the electrochemical processing results in several important advantages. The occurrence of leakage of electrolyte from the apparatus can essentially be eliminated by the container being given a self-sealing design, i.e. by the subatmospheric pressure in the chamber acting to hold the parts of the container together. Thus, the need for an external locking device which holds the parts of the container together during the electrochemical processing can be eliminated. Another advantage is that the container can be opened automatically after completed processing by pressure compensation in the chamber.

According to a preferred embodiment, a suction device is connected to an outlet of the container in order to draw electrolyte through the chamber during generation of the subatmospheric pressure therein. A suitable subatmospheric pressure can easily be achieved by adaptation of the suction effect to, for instance, the dimension of the electrolyte inlet of the container. The subatmospheric pressure should be such that leakage of electrolyte is essentially eliminated while at the same time a sufficient throughput of electrolyte is allowed during processing. The throughput of electrolyte should be such that a substantially constant quality of the electrolyte in the chamber is maintained during processing. The suction effect also permits safe withdrawal of gas which possibly forms in the chamber during processing.

According to one more preferred embodiment, the apparatus comprises at least two parts which in a cooperating and sealing fashion define the chamber during processing. These parts can thus automatically be held together by the subatmospheric pressure in the chamber during processing. A first part preferably comprises a shell-like casing which defines an internal space which extends to a mouth portion and within which the electrode member is arranged. A second part preferably comprises

the substrate and cooperates with the mouth portion while closing the space and defining the chamber. Thus, the space can automatically be closed by the second part, i.e. the substrate and any further components, being mounted in the apparatus. In this context, it is also preferred for the substrate holder to be connected to the casing to define the mouth portion and to have an annular receiving surface, which faces away from the electrode member, and for the substrate during closing of the space to be receivable on the receiving surface of the substrate holder, said receiving surface preferably being connected to the voltage source. Thus, the substrate serves as the second part cooperating with the casing, and the space in the casing is automatically closed and forms the chamber when the substrate is mounted in the apparatus. Moreover, the apparatus can easily and safely be connected to the voltage source since both the electrode member and the substrate holder are incorporated into the first part. If the receiving surface of the substrate holder is connected to the voltage source, the substrate is automatically connected to the voltage source during mounting in the apparatus. Preferably, a sealing means is arranged in the receiving surface of the substrate holder for sealing engagement with the substrate during processing. Thus, a self-sealing design of the container is easily achieved, by the subatmospheric pressure in the chamber striving to draw the substrate towards the sealing means in the receiving surface of the substrate holder.

According to another preferred embodiment, an abutment is formed to sealingly abut against one side of the substrate facing away from the substrate holder and with said side define a stabilising chamber, in which at least during processing such a pressure prevails that the substrate assumes an essentially plane form, i.e. suitably essentially the same pressure as in the chamber, or a somewhat lower pressure to bring the substrate into plane

engagement with a supporting surface of the abutment. This ensures that the substrate during processing assumes a plane form independently of the subatmospheric pressure in the processing chamber, and thus uniformity of the electrical field between the electrode and the substrate is also guaranteed, even during processing of flexible and/or thin substrates.

According to another preferred embodiment, a turbulence generator is arranged between the electrode member and the substrate holder, preferably comprising a stirring portion rotatable in the chamber between the electrode member and the substrate holder. Thus, an optional degree of turbulence can be achieved on the surface of the substrate in order to minimise concentration gradients in the electrolyte, above all at the surface of the substrate. The turbulence is thus generated mechanically and therefore is independent of the flow of electrolyte through the chamber. The flow of electrolyte through the chamber can be optimised for every situation. For instance, the flow can be kept so low that a constant composition in the electrolyte is exactly guaranteed, thereby making it possible to reduce the tank volume of electrolyte in the apparatus.

According to a preferred embodiment, the stirring portion is rotatable about an axis of rotation which coincides with a centre axis of the chamber. Thus a uniform distribution of the turbulence across the surface of the substrate is achieved. Moreover, a stable turbulent motion can be established in the chamber, especially if the chamber is rotationally symmetrical about said centre axis. Such a turbulent motion will by centripetal forces automatically urge gas, which possibly forms in the chamber during processing, towards the axis of rotation. Preferably, the container has an outlet which is arranged adjacent to the axis of rotation, in an upper portion of the chamber, so that this gas can be withdrawn in a controlled fashion from the chamber. The outlet is pref-

erably connected to the suction device, so that the gas is automatically drawn out together with the electrolyte. It is also preferred for the electrode member to be arranged above the substrate holder and to have a central hole adjacent to the axis of rotation. Thus, gas drawn towards the axis of rotation can flow through the hole into the upper portion of the chamber and from there out through the outlet.

According to one more preferred embodiment, the turbulence generator comprises a drive shaft whose one end is connected to the stirring portion arranged in the chamber and comprising at least one blade extending radially from said end. Each blade is designed to screen, radially outwards from said end, essentially the same amount of the surface of the electrode member. Each irregularity in the electrical field between the electrode member and the substrate results in a corresponding irregularity of the processed substrate. This embodiment guarantees uniform disturbance in the electrical field between the electrode member and the substrate when the stirring portion is caused to rotate. It is also preferred for each blade to be sheet-like in a plane parallel with the electrode member, and for each blade in said plane to be defined by two essentially rectilinear edges which extend from the end of the drive shaft at a given angle to one another. Thus a compact turbulence generator is provided, which without introducing any irregularities into the electrical field allows a desirably small distance between the electrode member and the substrate.

According to a preferred embodiment, the electrode member is plane, essentially inert during processing and formed with a plurality of perforations distributed across its surface. This allows a compact design with a small distance between the electrode member and the substrate, which enables low power consumption and use of small flows of electrolyte. The perforations result in an additionally improved withdrawal of gas forming adjacent

to the inert electrode member. The electrode member is preferably a dimensionally stable electrode made of mesh network.

The above discussion of preferred embodiments of the inventive apparatus is to a corresponding degree also applicable to the method of the invention.

Brief Description of the Drawings

The invention will now be described in more detail with reference to the accompanying drawings which by way of example schematically illustrate currently preferred embodiments.

Fig. 1 is a plan view from below of a container with an internal processing chamber before mounting of a substrate.

Fig. 2 is a sectional view of the container along line 2-2 in Fig. 1 after mounting of a substrate.

Fig. 3 is an overall view of an apparatus according to the invention.

Fig. 4 is an overall view of a plating apparatus with a container according to an alternative embodiment shown partly in cross-section.

Description of Preferred Embodiments

The following description of preferred embodiments is directed at plating of a substrate. A person skilled in the art understands that the description is also applicable to etching of a substrate, by reversing the voltage which drives the electrochemical process.

Figs 1-3 show a first embodiment of a plating apparatus according to the invention. The plating apparatus comprises a plating container or cell 1, which is shown in detail in Figs 1 and 2. The cell 1 comprises a shell-like casing 2 which defines an internal space 3. The space 3 is essentially circular-cylindrical and, thus, rotationally symmetrical about a centre axis A. The space 3 is defined by a plane end wall 4 and a circumferential peripheral wall 5. A circumferential opening in the peripheral wall 5 forms an electrolyte inlet 6.

An annular opening in the end wall 4 adjacent to the centre axis A forms an electrolyte outlet 7. A plane electrode plate 8 is arranged adjacent to the end wall 4 and serves as an anode. Connections 9 extend through the casing 2 from the anode 8 and form connecting means 10 on the outside of the casing 2 for connection to a voltage source 11 (Fig. 3). The anode 8 is suitably a dimensionally stable anode (DSA), for instance of iridium-oxide-activated titanium, which is formed as a plane fluid-permeable grid.

The cell 1 further comprises a mechanical turbulence generator 12 with a stirring portion which is rotatably arranged outside the anode inside the space 3. The turbulence generator 12 has a drive shaft 13 which is arranged through a hole 14 extending along the centre axis A of the casing 2. A packing 15 is arranged to sealingly engage the drive shaft 13. The drive shaft 13 extends through a central hole 16 in the anode 8 and defines with the edges of the hole 16 an annular gap essentially aligned with the electrolyte outlet 7. The proximal end of the drive shaft 3 is connected to a drive motor (not shown) which is activatable to rotate the stirring portion, which in this case comprises four blades 17 projecting from the distal end of the drive shaft 13. The blades 17 are sheet-like and arranged parallel with the anode 8. Each blade 17 is defined by two essentially rectilinear edges 18 which extend from the distal end of the drive shaft 13 at a given angle to one another (Fig. 1). During rotation, the blades 17 will thus screen, radially outwards from the distal end, essentially the same amount of the surface of the anode 8.

The cell 1 also comprises an annular substrate holder 60 which is arranged to define a mouth portion of the space 3. A plane receiving surface 19 of the holder 60 faces away from the anode 8 and is accessible from the outside of the casing 2. Connections 20 extend through the casing 2 from the holder 60 and form connecting means

21 on the outside of the casing 2 to be connected to the voltage source 11 (Fig. 3). A circumferential packing 22 is arranged in a circumferential groove 23 in the receiving surface 19 and projects therefrom. The substrate holder 60 is arranged to carry a substrate S plane-parallel with the anode 8.

Fig. 2 shows a substrate S which is mounted for plating in the cell 1. As will be described in more detail below, a subatmospheric pressure is established in the cell 1 during the plating process, which is filled with an electrolyte. This subatmospheric pressure draws the substrate S towards the receiving surface 19 of the cathode holder 60 so that the space 3 is sealingly closed and a plating chamber is defined. The substrate S is also brought into electric contact with the cathode holder 60. In this case the substrate consists, for example, of a metal sheet or a metallised body, such as a glass plate.

During plating, the substrate S is placed on the cathode holder. A subatmospheric pressure is established in the chamber by electrolyte being continuously drawn out through the central outlet 7 and a new electrolyte being allowed to be drawn into the chamber via the peripheral inlet 6. The size of the subatmospheric pressure in the chamber depends on the relationship between the suction effect at the outlet 7 and the pressure drop in the inlet 6 and associated conduits (cf. Fig. 3). In the shown embodiment, a subatmospheric pressure of about 300 kPa has been found to function well. The size of the subatmospheric pressure has been found not to be critical. If the subatmospheric pressure is too small, however, leakage of electrolyte from the cell 1 will arise. If the subatmospheric pressure is too great, the flow of electrolyte through the chamber will be too small. A certain throughput of electrolyte is in fact desirable since the supply of new electrolyte ensures that the electrolyte keeps a constant quality in the chamber, for instance with regard to composition, temperature, pH etc.

The plating is initiated by activation of the voltage source 11 (Fig. 3), whereby an electrical field is established through the electrolyte between the anode 8 and the substrate S, which functions as a cathode. During plating, the blades 17 are rotated continuously in the chamber for mixing of the electrolyte and generation of turbulence, above all on the surface of the substrate S. After completed plating, the pressure in the chamber is equalised, and the substrate S is released from the holder 60.

The cell 1 described above is included in a plating apparatus, whose other parts will be described below with reference to Fig. 3. The plating apparatus has an electrolyte feeding system 30 comprising a first tank 31 which via a feeding conduit 32 communicates with the electrolyte inlet 6 of the cell, and a second tank 33 which via a pump 34, an ejector 35 and a particle filter 36 communicates with the first tank 31. The suction side of the ejector 35 communicates with the electrolyte outlet 7 of the cell 1. The first tank 31 has an overflow 37 which communicates with the second tank 33. The first tank 31 is provided with a heater 38 for heating the electrolyte, a temperature sensor 39 and a pH meter 40.

In the preferred embodiment as described above, use is made of a so-called dimensionally stable anode 8, which is essentially inert relative to the electrolyte. The metal ions in the electrolyte which are consumed during plating are in this case replaced by means of a compensating device 41 which prepares a water-based slurry containing the corresponding metal ions. A pump 42 is arranged for dosed supply of the slurry to the second tank.

The selection of electrolyte is, of course, controlled by which metal is to be deposited on the substrate S. In nickel plating, the electrolyte can, for example, be based on nickel sulphamate and water. In this case, hydrogen ions form at the anode 8 during plating

while at the same time nickel ions are precipitated on the substrate S. These hydrogen ions are neutralised by adding an alkaline substance. This takes place by means of the compensating device 41, which prepares the slurry of an alkaline metallic salt, in this case nickel carbonate, nickel hydroxide, nickel oxide or nickel oxide hydroxide. The anions of the salt react with the hydrogen ions and form, depending on the selection of salt, water or carbon dioxide. Thanks to the metal ions and the alkaline substance being supplied in the form of a salt, the metal ions can in a controlled manner be supplied to the electrolyte based on the pH of the electrolyte measured by the meter 40.

During plating, also gas forms at the inert anode 8, in the above example oxygen. This gas can interfere with the electrical field between the anode 8 and the substrate S. The grid-like anode 8, however, allows at least part of the formed gas to move through the many perforations of the grid to the side of the anode 8 facing away from the substrate S, where the gas does not affect the electrical field. Moreover, the blades 17 will during rotation cause a turbulent motion in the electrolyte in the chamber. This turbulent motion generates centripetal forces which draw the gas formed at the anode 8 towards the centre of rotation where the gas in a controlled manner is drawn out through the outlet 7. Gas on the side of the anode 8 facing the substrate S can move freely up to the outlet 7 through the gap 16.

During plating, the pump 34 feeds electrolyte from the second tank 33 through the ejector 35 to the first tank 31. The ejector 35 draws electrolyte from the cell 1 into the first tank 31, and the suction effect of the ejector 35 causes electrolyte to circulate in a loop between the first tank 31 and the cell 1 while at the same time a subatmospheric pressure is established in the plating chamber of the cell 1. The filter 36 separates any particles in the electrolyte. A stable electrolyte

level is established in the first tank 31 via the overflow 37. The slurry is fed from the compensating device 41 to the second tank 33 based on the output signal of the pH meter 40. The plating apparatus is conveniently controlled by a main control unit (not shown), such as a computer or PLC.

Fig. 4 shows an alternative embodiment of a plating apparatus. Parts equivalent to those in Figs 1-3 have been given the same reference numerals, and the following description will focus on differences relative to the apparatus described above.

The cell 1 is provided with a form-stabilising abutment 50, which comprises a sheet-like body 51 with a central supporting surface 52, an engaging surface 53 extending round the supporting surface 52 and a circumferential groove 54 in the engaging surface 53. The abutment 50 also comprises a circumferential packing 55 which is mounted in the groove 54 and which projects from the engaging surface 53. Openings 56 are formed in the supporting surface 52 and extend through the body 51. The openings 56 are in fluid communication with the ejector 35.

During processing, the abutment 50 is engaged with the substrate S which is carried by the substrate holder 60. The surface 53 sealingly abuts against the substrate S, so that a stabilising chamber is defined between the supporting surface 52 and the substrate S. During processing, the ejector 35 establishes such a pressure in the stabilising chamber that the substrate S is held essentially plane, suitably by the substrate S being applied by suction to the supporting surface 52. Thus the pressure in the stabilising chamber is suitably essentially the same as or lower than the pressure in the plating chamber on the opposite side of the substrate S. According to an alternative embodiment (not shown), the supporting surface 52 is replaced by a hole which with the substrate defines the stabilising chamber. In this

embodiment, a pressure is established in the stabilising chamber which is essentially the same as the pressure in the plating chamber, whereby the substrate S is held essentially plane during processing. The pressures on both sides of the substrate S can possibly be adjusted by means of a variable throttle (not shown) or the like in the conduit between the outlet 7 and the ejector 35 and/or in the conduit between the openings 56 and the ejector 35. The embodiment in Fig. 4 is particularly advantageous when processing flexible and/or thin substrates, such as metal foils, since these can be guaranteed to be held fully plane during processing.

In Fig. 4 it may also be noted that the electrolyte feeding system 30 is somewhat simplified and only comprises a first tank 31, a pump 34 and an ejector 35.

It will be appreciated that the invention is not restricted to the above detailed description of currently preferred embodiments and can be modified within the scope of the appended claims. For example, a corresponding apparatus and a corresponding method can be used for electrochemical etching. The design of the electrolyte feeding system is not decisive to the invention and, for instance, the electrolyte need not be fed in a closed loop. In some situations, the subatmospheric pressure in the chamber can be established without electrolyte passing through.

CLAIMS

1. An apparatus for electrochemical processing of a substrate (S), comprising a container (1) having a chamber for holding an electrolyte, an electrode member (8) arranged in the chamber, and a substrate holder (60) arranged in the chamber and adapted to carry the substrate (S), a voltage source (11) being connected to the electrode member (8) and the substrate holder (60) in order to establish, during processing, an electrical field in the electrolyte between the electrode member (8) and the substrate (S) carried by the substrate holder (60), characterised by a pressure control means (34, 35) which is adapted to establish a subatmospheric pressure in the chamber during the electrochemical processing.

2. An apparatus as claimed in claim 1, wherein the pressure control means comprises a suction device (35) which is connected to an outlet (7) of the container (1) to draw electrolyte through the chamber while generating said subatmospheric pressure.

3. An apparatus as claimed in claim 1 or 2, wherein the container (1) comprises at least two parts (2, S) which in a cooperating and sealing manner define the chamber during processing.

4. An apparatus as claimed in claim 3, wherein a first part comprises a shell-like casing (2) which defines an internal space (3) which extends to a mouth portion and within which the electrode member (8) is arranged, and wherein a second part comprises the substrate (S) and cooperates with the mouth portion while closing the space (3) and defining said chamber.

5. An apparatus as claimed in claim 4, wherein the substrate holder (60) is connected to the casing (2) for defining the mouth portion and has an annular receiving surface (19), which faces away from the electrode member

(8), and wherein the substrate (S) during closing of the space (3) is receivable on the receiving surface (19) of the substrate holder (60), said receiving surface preferably being connected to the voltage source (11).

6. An apparatus as claimed in claim 5, wherein a sealing means (22) is arranged in the receiving surface (19) of the substrate holder (60) to sealingly engage the substrate (S) during processing.

7. An apparatus as claimed in any one of the preceding claims, further comprising an abutment (50) which is formed to sealingly abut against one side of the substrate (S) facing away from the substrate holder (60) and define with said side a stabilising chamber, in which at least during processing such a pressure prevails that the substrate assumes an essentially plane form.

8. An apparatus as claimed in any one of the preceding claims, comprising a turbulence generator (12) between the electrode member and the substrate holder.

9. An apparatus as claimed in claim 8, wherein the turbulence generator (12) comprises a stirring portion rotatable in the chamber between the electrode member (8) and the substrate holder (60).

10. An apparatus as claimed in claim 8 or 9, wherein the stirring portion is rotatable about an axis of rotation which coincides with a centre axis (A) of the chamber.

11. An apparatus as claimed in claim 10, wherein the chamber is rotationally symmetrical about said centre axis (A).

12. An apparatus as claimed in claim 10 or 11, wherein the container (1) comprises an outlet (7) which is arranged in an upper portion of the chamber adjacent to said axis of rotation.

13. An apparatus as claimed in claim 12 in combination with claim 2, wherein the outlet (7) is connected to the suction device (35).

14. An apparatus as claimed in claim 12 or 13, wherein the electrode member (8) is arranged above the substrate holder (60) and has a central hole (16) adjacent to said axis of rotation.

15. An apparatus as claimed in any one of claims 9-14, wherein the turbulence generator (12) comprises a drive shaft (13) whose one end is connected to the stirring portion arranged in the chamber and comprising at least one blade (17) extending radially from said end, each blade (17) being formed to screen, radially outwards from said end, essentially the same amount of the surface of the electrode member (8).

16. An apparatus as claimed in claim 15, wherein each blade (17) is sheet-like in a plane parallel with the electrode member (8), and wherein each blade (17) in said plane is defined by two essentially rectilinear edges (18) which extend from said end at a given angle to one another.

17. An apparatus as claimed in any one of the preceding claims, wherein the electrode member (8) is plane, essentially inert during processing and formed with a plurality of perforations distributed across its surface, the electrode member (8) preferably being a dimensionally stable electrode made of mesh network.

18. An apparatus as claimed in any one of the preceding claims, wherein the substrate holder (60) is arranged to carry the substrate (S) opposite to and essentially plane-parallel with the electrode member (8).

19. An apparatus as claimed in any one of the preceding claims, comprising an electrolyte inlet (6), preferably a circumferential opening, in a circumferential wall portion (5) between the electrode member (8) and the substrate holder (60).

20. A method for electrochemical processing of a substrate (S) in a chamber, comprising the steps of arranging the substrate (S) in the chamber, introducing an electrolyte into the chamber, and establishing an elec-

trical field in the electrolyte between an electrode member (8) and the substrate (S) for performing the electrochemical processing, characterised in that a subatmospheric pressure is established in the chamber at least during processing.

21. A method as claimed in claim 20, wherein the electrolyte during processing is drawn through the chamber in such manner that said subatmospheric pressure is established in the same.

22. A method as claimed in claim 20 or 21, wherein the chamber is defined by at least two cooperating parts (2, S), which during processing are sealingly held together by the subatmospheric pressure.

23. A method as claimed in any one of claims 20-22, wherein a stirring portion of a turbulence generator (12) during processing is caused to rotate in the chamber for generating turbulence in the electrolyte positioned between the electrode member (8) and the substrate (S).

24. A method as claimed in any one of claims 20-23, wherein a turbulent motion about a centre axis (A) of the chamber is imparted to the electrolyte positioned between the electrode member (8) and the substrate (S)), whereby any gas formed in the chamber is urged towards the centre axis (A) and out through at least one outlet (7) arranged adjacent to the centre axis (A) in an upper portion of the chamber.

25. A method as claimed in claim 24, wherein the subatmospheric pressure is generated by means of a suction device (35) which draws electrolyte out of the chamber through said at least one outlet (7).

26. A method as claimed in any one of claims 20-25, wherein such a pressure is established, at least during processing, at one side of the substrate (S) facing away from the chamber that the substrate (S) assumes an essentially plane form.

27. A method as claimed in claim 26, wherein one side of the substrate (S) facing away from the chamber,

at least during processing, is applied by suction to an essentially plane supporting surface (52).

28. An apparatus for electrochemical processing of a substrate (S), comprising a container (1) having a chamber for containing an electrolyte, an electrode member (8) arranged in the chamber, and a substrate holder (60) arranged in the chamber and adapted to carry the substrate (S), a voltage source (11) being connected to the electrode member (8) and the substrate holder (60) in order to establish, during processing, an electrical field in the electrolyte between the electrode (8) and the substrate (S) carried by the substrate holder (60), the container (1) comprising at least two parts (2, S) which in a cooperating and sealing manner define the chamber during processing, characterised by a pressure control means (34, 35) which is adapted to establish a subatmospheric pressure in the chamber during the electrochemical processing, the pressure control means comprising a suction device (35) which is connected to an outlet (7) of the container (1) to draw electrolyte through the chamber while generating said subatmospheric pressure.

29. A method for electrochemical processing of a substrate (S) in a chamber, comprising the steps of arranging the substrate (S) in the chamber, introducing an electrolyte into the chamber, and establishing an electrical field in the electrolyte between an electrode member (8) and the substrate (S) for performing the electrochemical processing, the chamber being defined by at least two cooperating parts (2, S) which during processing are sealingly held together, characterised in that the electrolyte is drawn, during processing, through the chamber so that a subatmospheric pressure is established in the chamber at least during processing, said subatmospheric pressure holding the cooperating parts together.

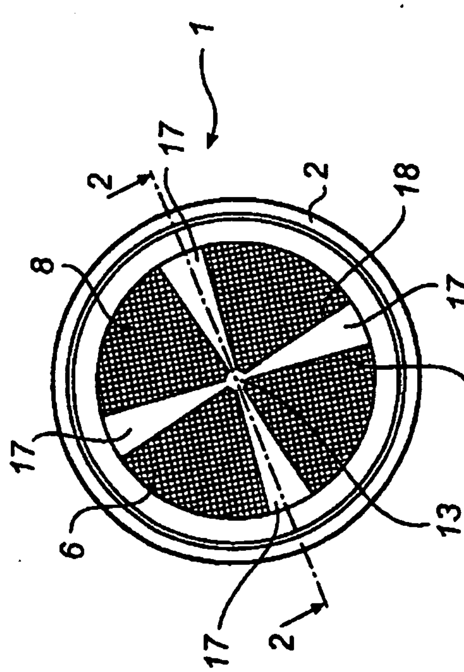


Fig. 1

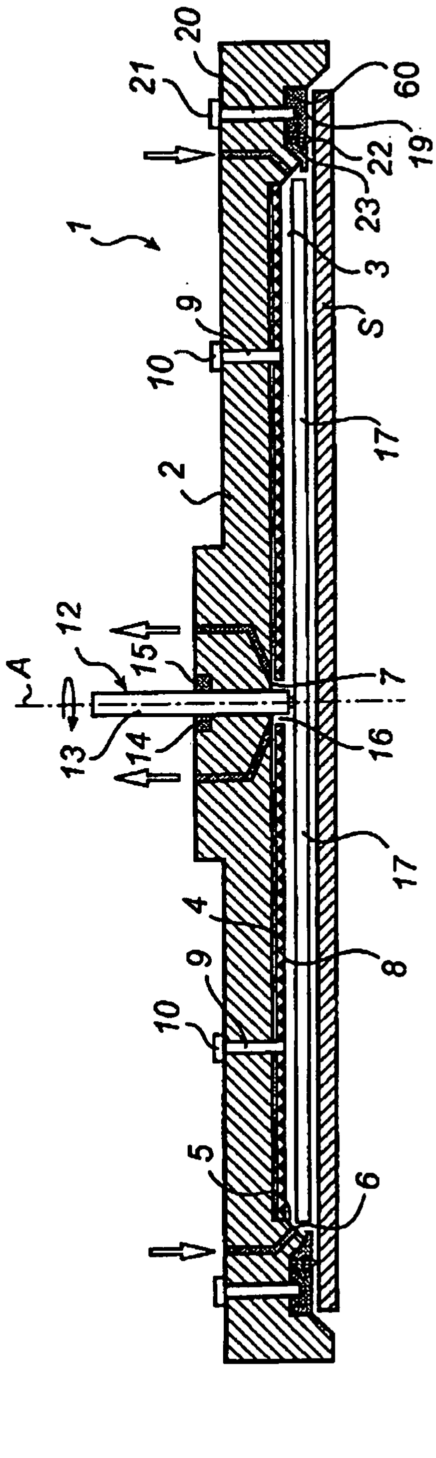


Fig. 2

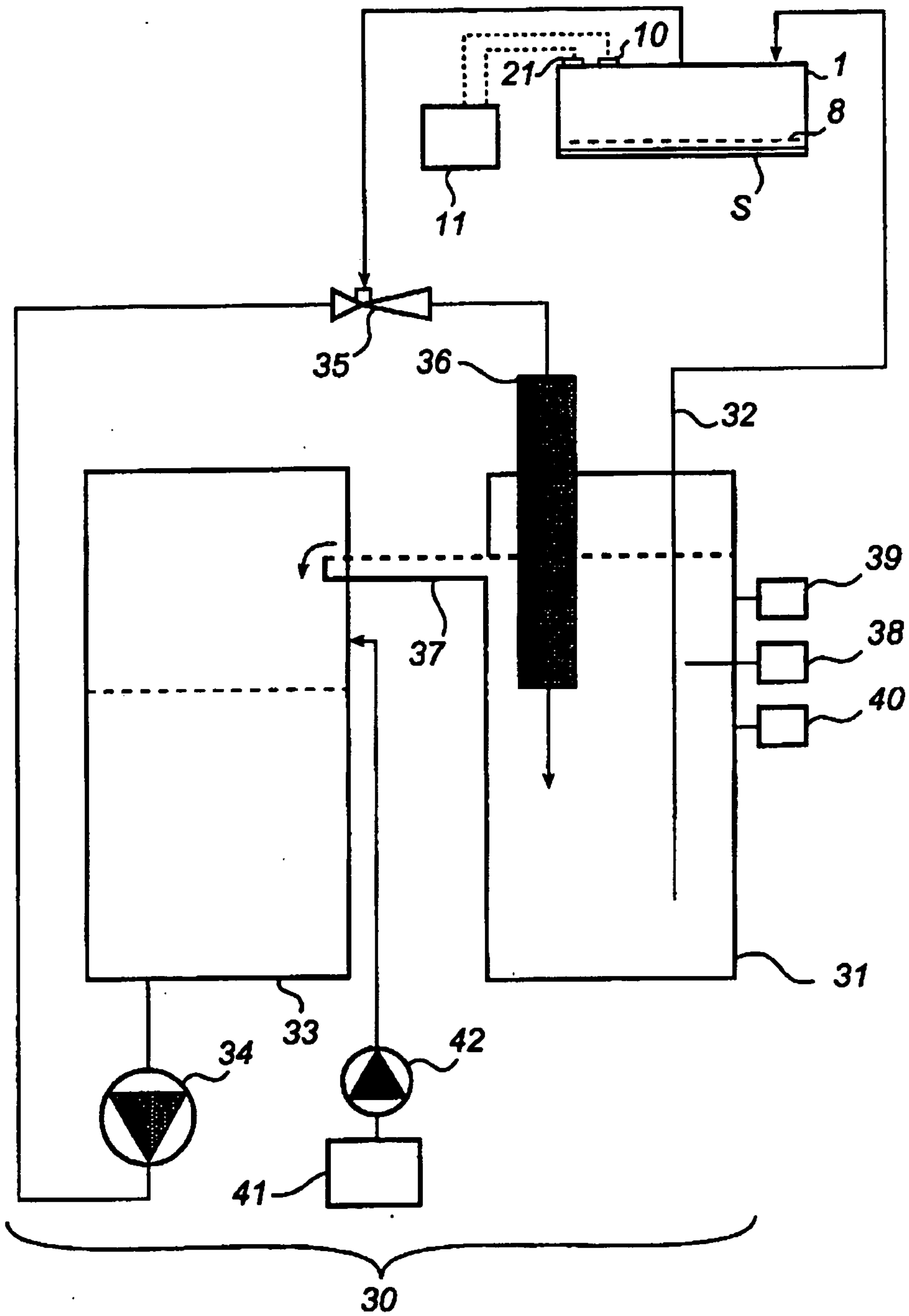
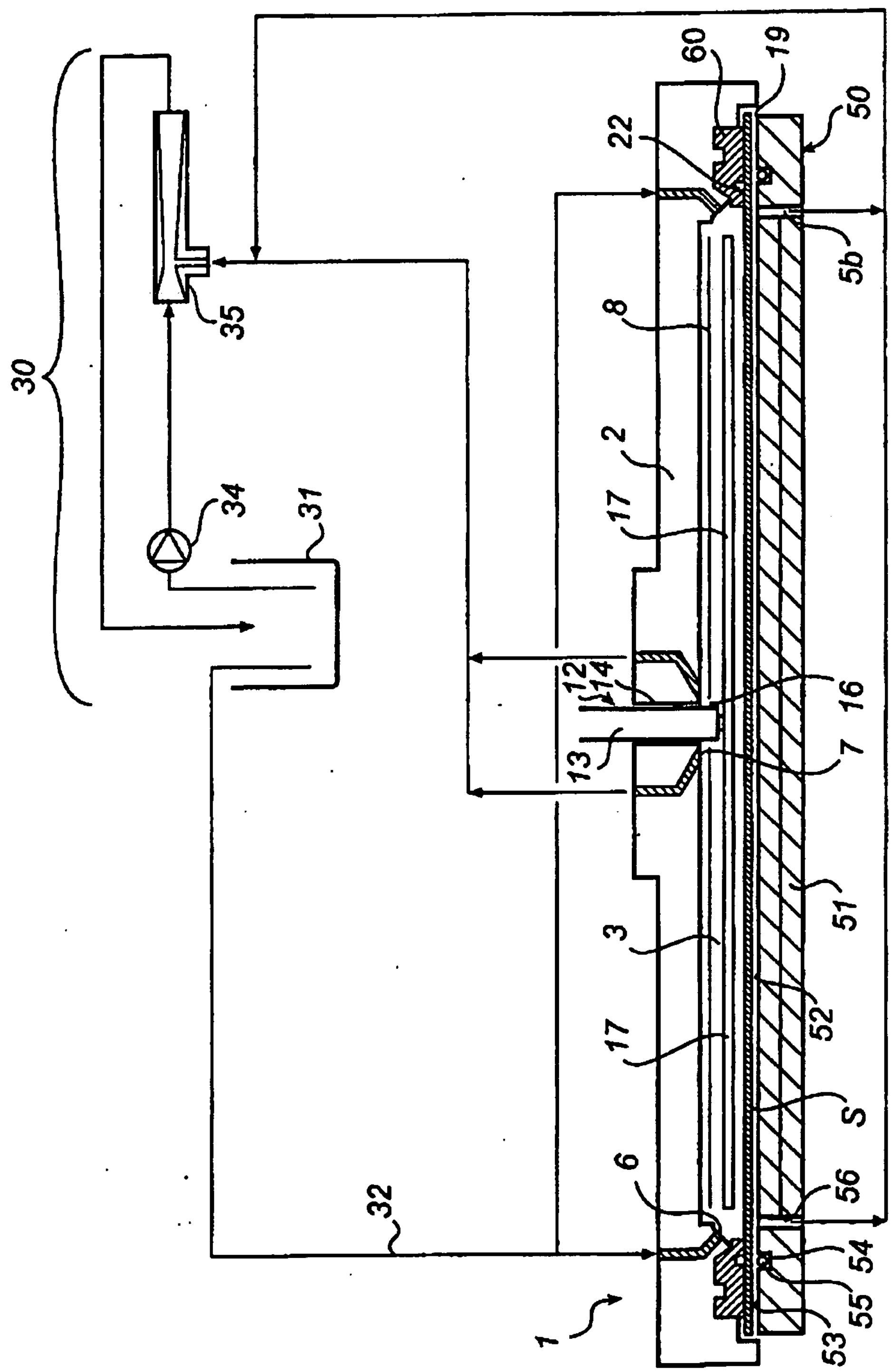


Fig. 3



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5b
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S
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Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 01/00824

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: C25D 5/00, C25D 5/08, C25D 17/00, C25D 21/10, C25F 7/00 // C25D 001/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: C25D, C25F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPIL,EDOC,JAPIO

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 4081347 A (O.A. BECKER), 28 March 1978 (28.03.78), column 1, line 28 - column 3, line 42; column 6, line 56 - column 12, line 9, figures 1-3 --	1-27
A	US 5427674 A (C.G. LANGENSKIÖLD ET AL), 27 June 1995 (27.06.95), column 1, line 65 - column 4, line 9, figures 1,2, abstract --	3-19,22-27

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 July 2001	12 -07- 2001
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Ingrid Grundfelt/MP Telephone No. +46 8 782 25 00

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

International application No.
PCT/SE 01/00824

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